Space Weather Technical Forecast

Issued on Wednesday, 19 January 2022 at 12:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight Chance of G1 and Chance of isolated M-class flares (R1/R2 radio blackouts) throughout. Electron Flux likely to be High during diurnal maximum with fluence above the 1e8 integrated pfu Active level.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with a Long Duration M1.5 X-ray flare from sunspot region AR2929 at 18/1744 UTC, this was followed by a C5.7 flare from AR2930 at 18/1951 UTC. The ejecta from this event was clearly visible in coronagraph imagery, it will be analysed for an Earth-directed component in due course. No other Coronal Mass Ejection (CME) event of note are visible in coronagraphs for the period. There are now four active regions on the visible disc. AR2929, AR2930 and AR2933 are the most noteworthy regions being bipolar. AR2927 in the southwest is uni-polar, stable and appears to be fading.
The C2 flare from AR2929 on 16 January produced a CME directed mainly to the northwest. This may pass Earth as a glancing blow early on Thursday 20 January.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1 was elevated due to connection to a high speed stream from CH44/-. The solar wind speed was typically between 550-600 km/s with occasional increases to Strong (above 600 km/s). The solar wind density was near or slightly above average. The IMF was mainly weak, near 5nT before becoming moderate near 9nT for a time after 18/2300 UTC, while the north-south component varied between -9 and +8nT. The phi angle started the period mainly negative (towards the sun) but with some brief forays into a positive sector., The net result of the above solar wind measures was provisionally Quiet to Unsettled (Kp2-3) geomagnetic activity with a Moderate Geomagnetic Storm (Kp6) observed between 19/0000 UTC and 19/0300 UTC and a Minor Geomagnetic Storm (Kp5) observed in the following period. This probably resulting from a CME that departed the sun around the 15th.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 remained at Background levels throughout. High energy electron flux (greater than 2MeV) measured at GOES 16 was at Moderate to High levels, with a peak value of 4360 pfu at 18/1605 UTC. Electron fluence initially remained flat before quickly, exceeding the 1e8 Active threshold at 18/1800 UTC, with the 19/0000 UTC observation value of 1.5e8 integrated pfu recorded.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be mostly Low and further C-class flares are expected days 1 and 2 (19 and 20 Jan) each day with a chance of a further M-class flare. The probabilities of flares decreasing from day 3 (21 Jan) as two of the sunspot regions rotate off the visible disc.

Solar Wind / Geomagnetic Activity: The CME from the C2 flare from AR2929 on 16 January may carry an Earth-directed component, with a possible glancing blow arriving early in the UTC

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day of Thursday 20 January. This gives a Slight Chance of G1. The CME from the M1.5 flare on the 18th may also have a partial Earth-directed component with an arrival time around Saturday 22 January. The only coronal hole feature due in the four days is expected to be the current one, CH44. A gradual decline is predicted through the period. Quiet to Unsettled geomagnetic activity is expected with a chance of further Active intervals on days 1 and 2 (19 and 20th January). Should the recent CMEs have an Earth directed component, then some enhancement in geomagnetic activity can be expected to G1.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at Background levels. The high energy electron flux (greater than 2MeV) is expected to be continue to breach High flux levels through the period, especially near the diurnal maximum. This will need reassessing should CMEs impact Earth. The 24-hour fluence remaining above the Active threshold to start the period with a decline likely to be observed by day 3 (21 January).

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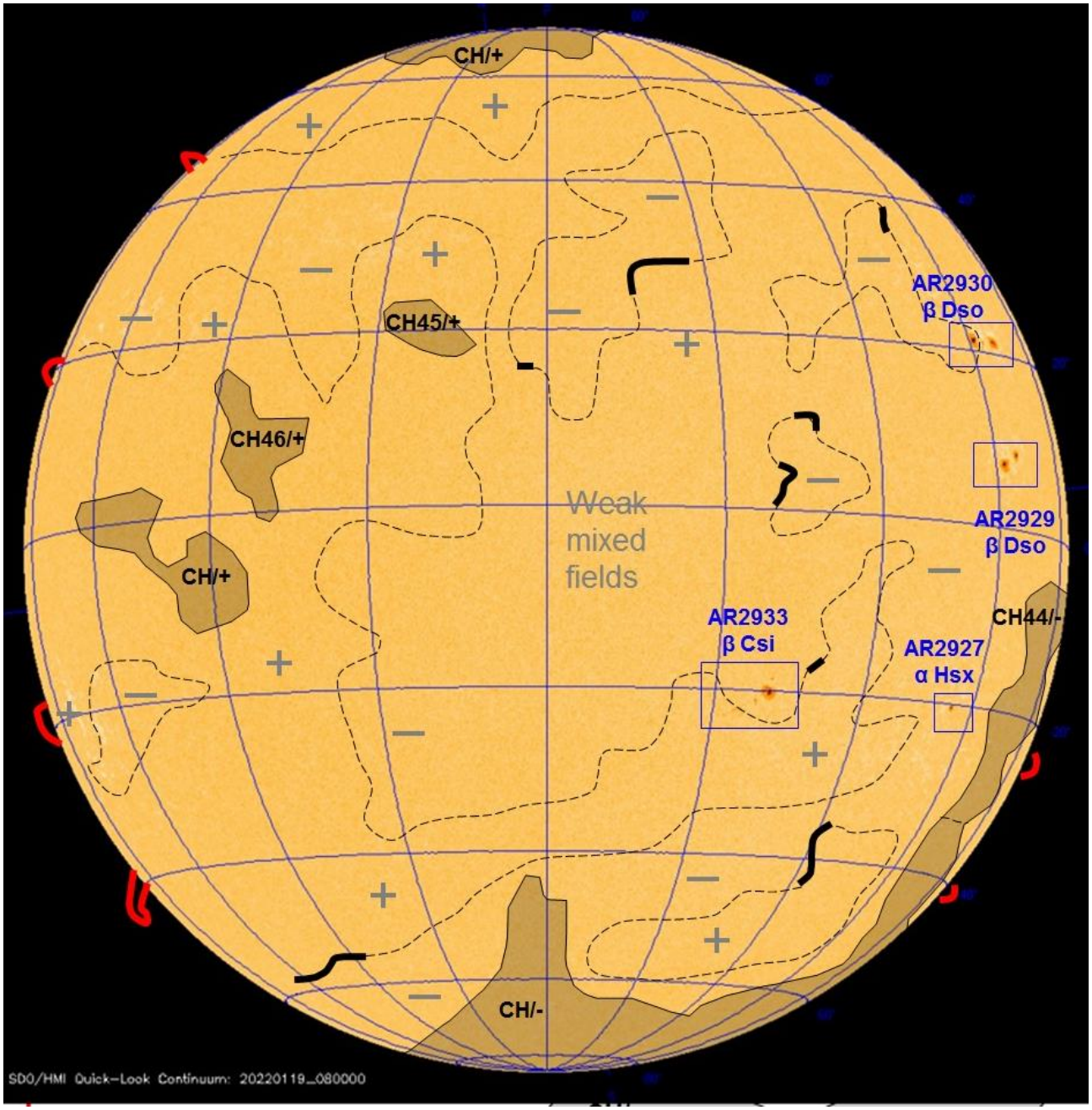
Figure 1. Solar Analysis Valid 0800 UTC, 19 January 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CME from the C2 flare from AR2929 on 16 January is now considered to perhaps carry an Earth-directed component, as suggested by some MOSWOC Enlil Ensemble members. These point towards arrival early in the UTC day of Thursday 20 January, with a resultant Slight Chance of G1 indicated, but with low confidence. This analysis exclusively considered the portion of ejecta seen heading northwest on Lasco coronagraphs (also correlated with STEREO A COR2 data). There were also hints of material seen heading north and northeast on Lasco C2 at the same time - the attribution for these streams is not clear, however it is possible that they were produced in the same event, and this was therefore more of a partial halo CME. This uncertainty has influenced the inclusion of the northwestward portion in the forecast as a Slight Chance of G1, however it remains that confidence is low for the event as a whole.
The CME from the M1.5 flare on the 18th has been analysed and from available imagery this may have a limited Earth-directed component arriving on 22 January. The vast bulk of this CME was directed northwestwards from the sun and much of it will miss Earth's orbit. The only coronal hole feature due in the four days is expected to be the current one, CH44, which is now mature, with resultant geomagnetic activity very likely to have already peaked. A gradual decline toward is expected with no further enhancements barring the possible impacts from CMEs mentioned above.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	20	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
17/0235 UTC	Partial	Long period C2 flare from AR2926 on 16 Jan	NW limb	562 km/s	20/0001 UTC	Low confidence glancing blow
18/2140 UTC	Partial	Long period M1.5 flare from AR2929 on 18 Jan	NW limb	950 km/s	22/0001 UTC	Low confidence glancing blow

Figure 2: Met Office ENLIL Ensemble plot indicating possibility for two CME glancing blows affecting Earth.

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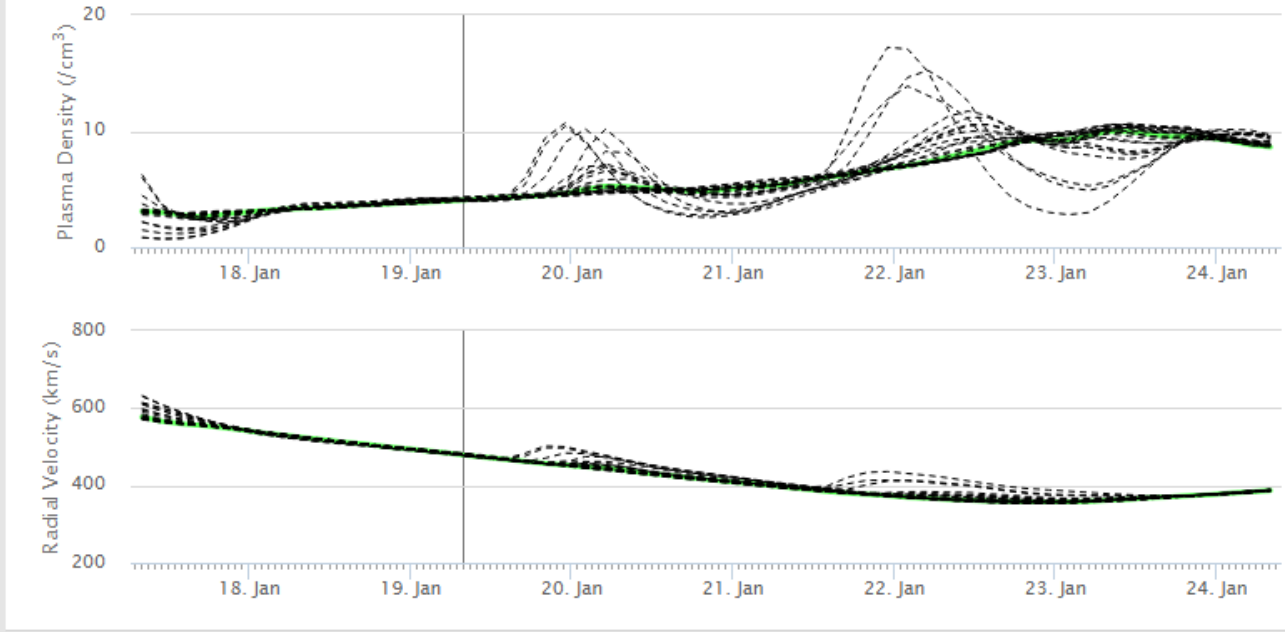

Radio Blackouts - X-Ray Flares:

The overall trend in the front-sided sunspot groups has been of stability or slight decline in the past 24 hours. Despite this an M1.5 flare was observed from AR2929. There appears little prospect of significant returning regions arriving over the eastern limb in the four-day period. The daily risk of M-class flares remains higher than would normally be anticipated to reflect the recent M1.5 event, albeit with a decreasing probability as the active regions rotate off the visible disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	20	10	5
Very Active	R3 to R5 X Class	No	5	3	1	1

Figure 3: X-ray flux plot at GEO with recent flares over past 24 hours.

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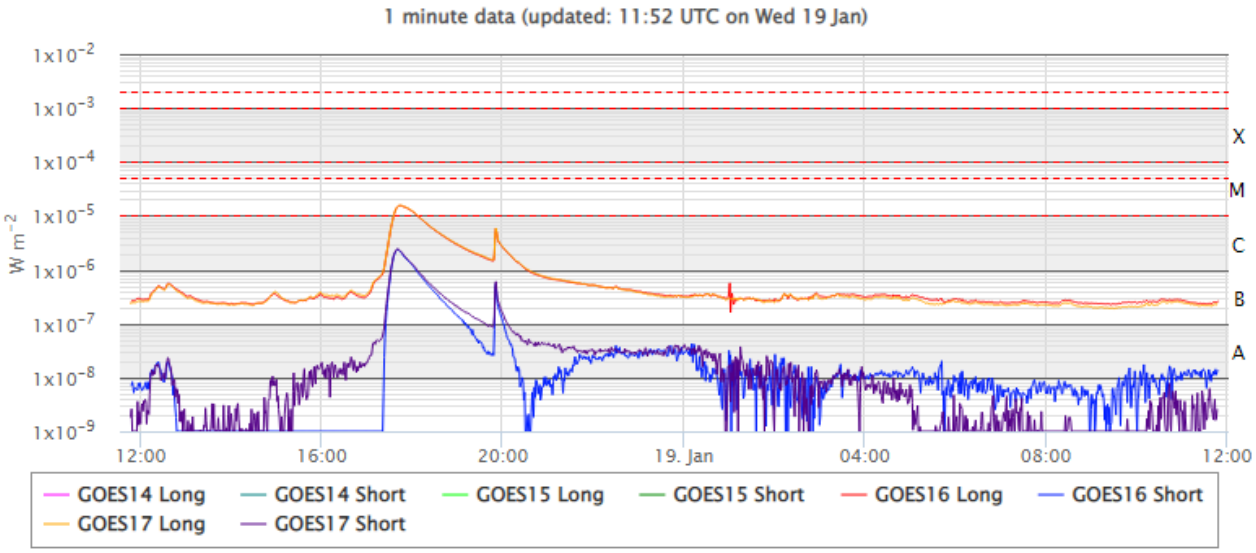
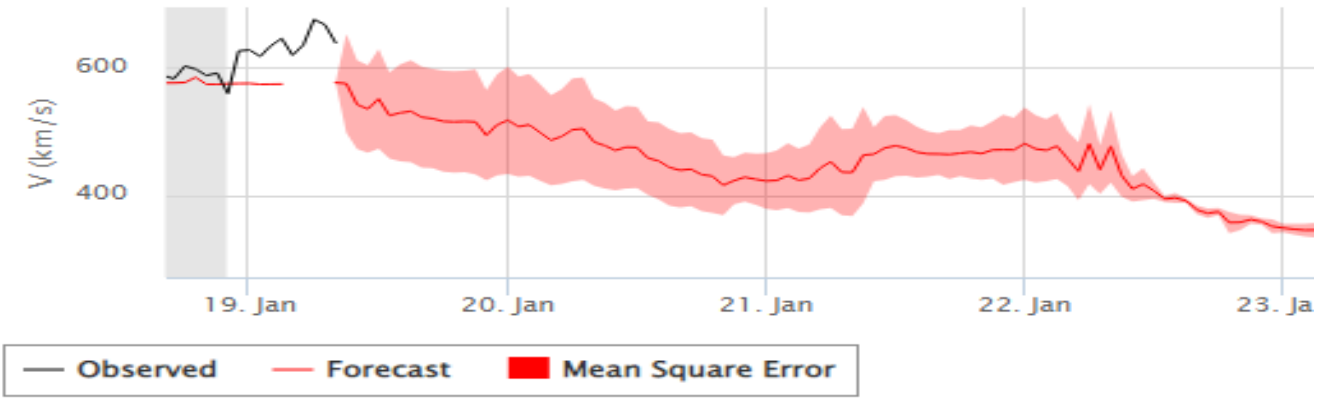


Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 remains at Background levels. The M1.5 flare observed late on the 18th is leading to a slightly raised risk of S1 in the coming four-day period, although the effect is very slight.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Met Office Solar Winds Prediction Model (SWPM) with decline predicted.



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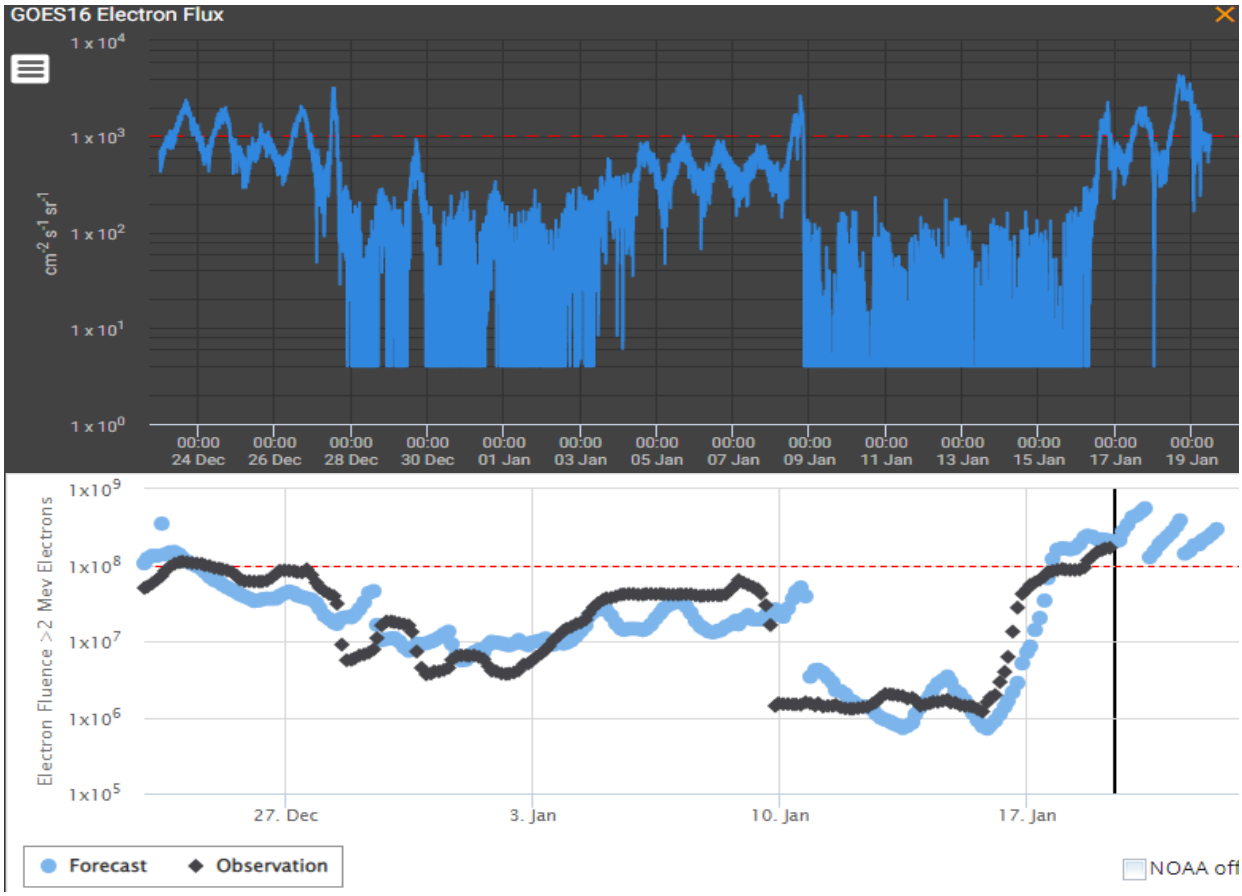
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has exceeded the 1e3pfu High level and is expected to occasionally breach this value for the next four days, especially during the diurnal maximum. This is in response to the ongoing high speed stream. 24-hour integrated fluence is expected to remain above the Active threshold, at least for days 1-3 (19th-21st). Though confidence drops markedly with the potential complication of the incoming CMEs which may affect Earth in the coming days.
The current level of response in high energy electrons is greater than that seen on last rotation in reaction to CH44's predecessor. REFM guidance is considered to be reasonably good at present, with levels mostly above the 1e8 integrated pfu threshold.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	100	90	70	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	5	1	1	1

Figure 5: High energy electron flux at GEO and Met Office REFM output (lower plot) since previous rotation on 23 December 2021.



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